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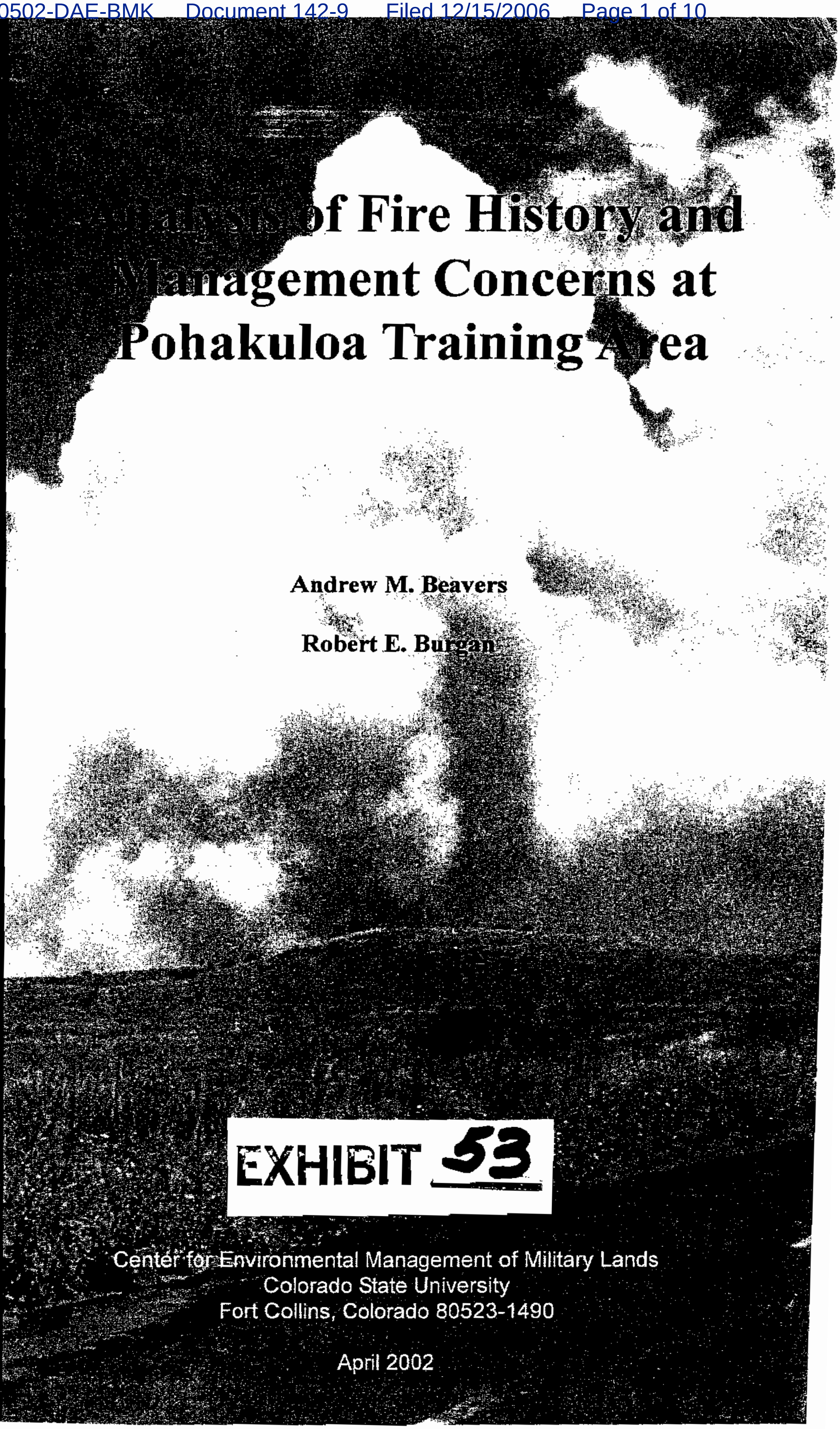

Analysis of Fire History and Management Concerns at Pohakuloa Training Area

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EXHIBIT 53

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Fire History of Pohakuloa Training Area

1.1 Summary

Historically, fire in the area of PTA was most likely rare and of little significance, limited to volcanically started fires and occasional lightning ignitions. Military use for live fire exercises and target practice has increased ignition frequency dramatically and resulted in numerous small fires, though it appears that much of the threat to endangered species populations is a result of off post ignitions.

1.2 Fire History Methods

The historical fire regime of the Hawaiian Islands is documented in Analysis of Fire Management Concerns at Makua Military Reservation (Beavers et al. 1999). Recent fire history at PTA was inferred as best as possible from existing fire records and documentation provided by USARHAW, the Federal Fire Department at PTA, the USFWS, and the State of Hawaii Department of Land and Natural Resources (DLNR). Trend analyses were performed on the relation of fire frequency to year, month, time of day, and location. We also attempted to relate fire frequency with use of the installation. However, utilization records are archived for only two years, and because of the variability in the location of training throughout the installation this analysis was not possible.

1.3 Fire History Results

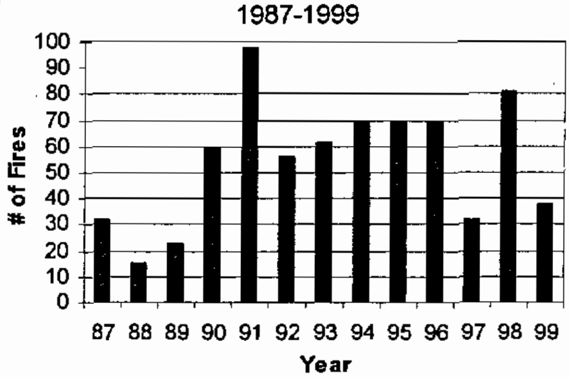
All available records were compiled into the fire history in Appendix 1. These records were supplied by the PTA Federal Fire Department, PTA Range Control, the USFWS, and the State of Hawaii DLNR. Fire records were numerous for PTA but most were incomplete. Many records included a date, time, and location for the fire but very little information was available about the size of fires or the weather conditions during the fires. The amount of information included in reports seemed to be related to the year, probably as a result of changes in management. For this reason, many of the analyses utilized only years in which data was available for the parameter of interest.

Many fires were not recorded at all. The most notable omission is fires that occurred in the impact area, where only 16 fires were recorded over the 13 years of records reviewed. There were, by all accounts, tens to hundreds of fires in the impact area during this time period. However, because these fires tend to be small, they have little chance of escaping the boundary of the impact area, generally are not suppressed, and often were not recorded. These omissions surely affected the results of the analysis to some degree, but the extent to which this is true cannot be known.

The limitations mentioned above prohibited a complete analysis of fire trends. However, we did conduct analyses on the year, month, and time of fires, the acreage, and the relation to weather conditions. Analyses were also conducted on the ignition source and location for years in which that information was available.

Figure 3

Number of Fires per Year at PTA
1987-1999



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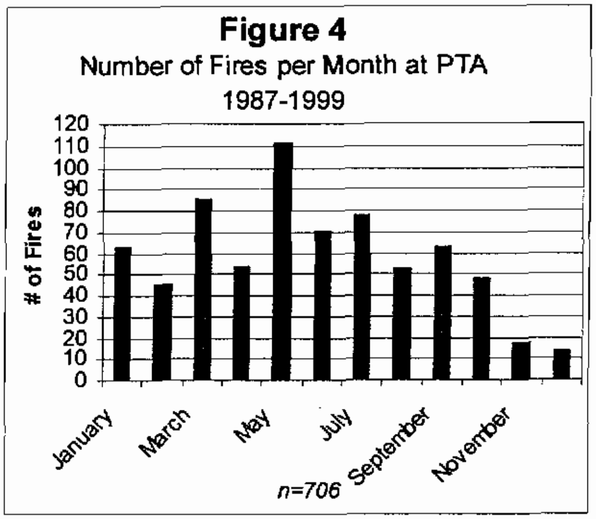
No trend was evident in the number of fires per year (Figure 3) over the last decade. There was some interesting variation in the data, particularly a marked decrease in the number of fires in 1997 and 1999 and an increase in 1991.

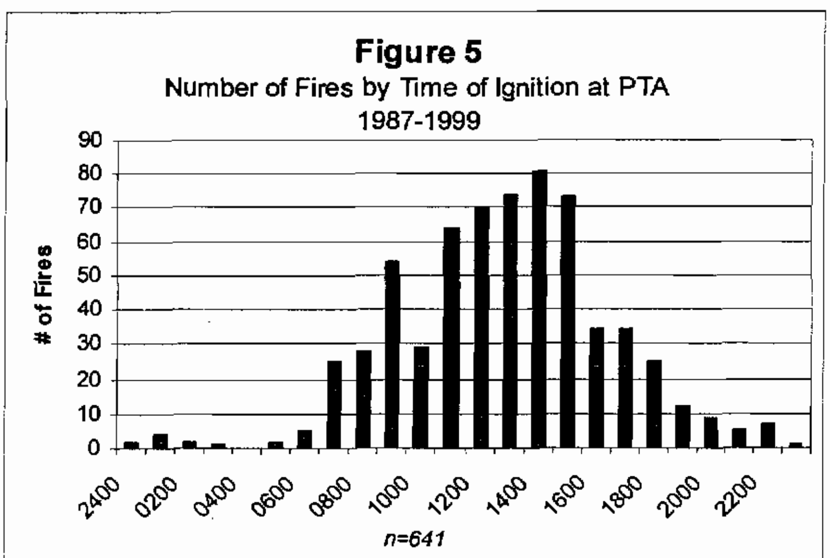
There is little information to suggest that there was an actual decrease in the number of fires during 1997 and 1999. Most fire indicators, such as the ongoing drought that began in early 1997, suggest that an increase should have been observed. These decreases may simply represent poor record keeping or lost records, but there is no way to definitively assess the cause. The infrequent fires from 1987-1990 is almost certainly a result of lost records. Attaining information about this period was difficult due to the lack of available personnel who were at PTA at the time and who may have known what happened to any records that may have existed, and the government's policy on record keeping which is to dispose of all non-vital documents after several years.

Nineteen Ninety was the wettest of the past 17 years with an annual total rainfall nearly twice the average. It was followed by one of the driest years, 1991 (Bern 1995) which also showed a notable spike in fire frequency. This may have been caused by increased vegetation production as a result of the wet year of 1990 and a corresponding increase in fuel loading in

1991 when precipitation decreased. These climatic factors may have resulted in larger than normal fuel loads and an increase in fire frequency that year.



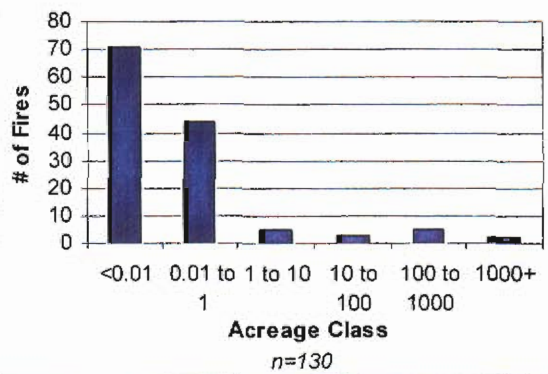
The climate fluctuations that caused this spike are notable for their impact on vegetation as well as their influence on fire frequency. During a Land Condition Trend Analysis (LCTA) survey in 1993, vegetation cover, density, and biomass production were lower than all previous surveys (Bern 1995), suggesting that the large precipitation decrease observed in 1991-1992 did affect vegetation recovery. This is important because of its implications for post fire recovery and fuel management. Low precipitation or other deleterious climate variations could increase the impact of fires by prolonging the time necessary for native vegetation recovery and thereby increase the opportunity for alien species invasion. Alien species tend to be generalists and are better adapted to a wider range of environmental conditions. Therefore, they are more tolerant of drought and other climatic variations that produce negative impacts on the natives. Thus, during periods of stress for the native populations, the exotics have an increased competitive advantage.



The number of fires per month exhibits a rough curve peaking in the months of March to July (Figure 4). One might expect this because these are the driest months of the year (Bern 1995). However, PTA is dry throughout the year and the amount of precipitation received during the winter is probably not enough to change the probability of fire by any significant amount. For this reason we would not expect to see any noticeable annual cycle in fire frequency. The main cause of monthly variation in the data is probably the

frequency and intensity of use by the military. Increases in ignition sources as a result of increases in training will lead to increases in the number of fires. The months of highest use by the military vary from year to year, possibly explaining some of the variation in fire frequency per month. We attempted to link fire frequency per month with military usage of the installation. However, the results were ambiguous because only two years of utilization records were available and there was substantial variability in both the utilization of the installation and the number of fires per month.

Figure 6
Number of Fires by Acreage Class at PTA 1987-1999



Fire frequency by time of day (Figure 5) illustrates that fires occur most frequently during the early afternoon and least frequently at night. Eighty percent of all recorded fires started between 0900 and 1700, the hours when levels of training and fire danger indices tend to be at their highest. No explanation is immediately apparent for the low number of fires occurring between 1000 and 1100 hours. It appears to be simply an anomaly of the data.

The acreage per fire (Figure 6) was only available for approximately 20% of the fire records, but we can conclude from the available evidence that the huge majority of fires are very small (<1 acre). When fire size is taken into account (Figure 7), it becomes clear that a small number of large fires are responsible for most of the acreage burned. Over 97% of the recorded acres damaged by fire from 1987-1999 were burned by eight individual fires of 100 acres or more. The two Kipuka Kalawamauna fires, which started off post, account for 72% of all acres burned within PTA's boundaries. This is significant because it demonstrates that, though military training does pose a danger, the real threat to endangered species at PTA is from civilian

Figure 7
Percent of Recorded Area Burned 1987-1999 by Fire Size Class at PTA

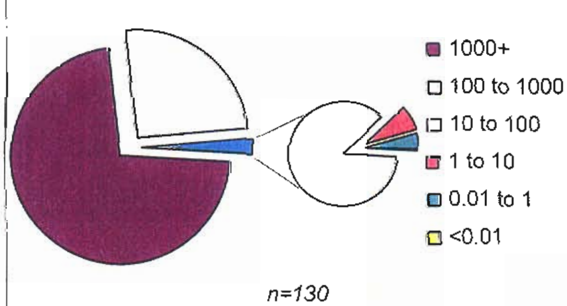
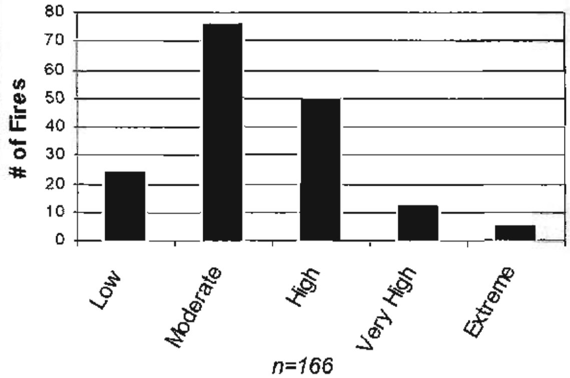


Figure 8
Number of Fires Occuring in Each Fire Weather Rating at PTA 1987-1999



ignition sources. This topic is discussed in further detail in the Pre-Suppression and Fuel Management Options section.

Figure 8 depicts the number of fires recorded as starting under one of the five fire weather ratings (hereafter referred to as fire danger ratings) developed by the Army. The indices were determined from a combination of the ignition component (IC), defined as a measure of "the probability of a firebrand producing a fire that will require suppression action" (Deeming et al. 1978), and the burning index (BI), which is a measure of the fire's probable intensity. Table 5 depicts the variables used to determine a day's fire danger rating.

Table 5: The fire danger rating system used by the Army at PTA until 1997.

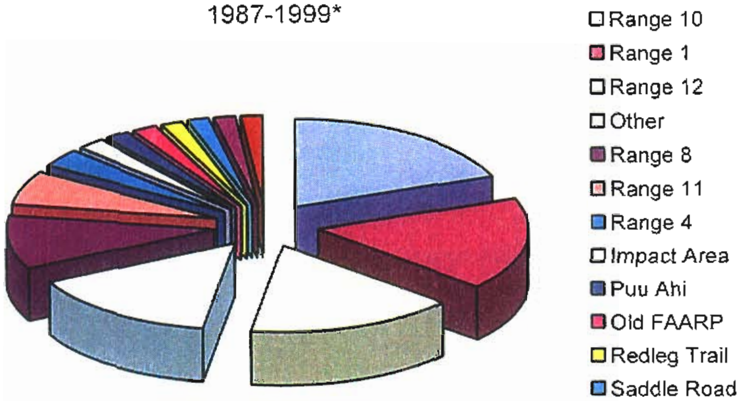
Burning Index	*Ignition Component* 0 - 20	21 - 45	46 - 65	66 - 80	81+
0 - 5	Low	Low	Low	Moderate	Moderate
6 - 17	Low	Moderate	Moderate	Moderate	High
18 - 22	Moderate	Moderate	High	High	Very High
23 - 28	Moderate	High	Very High	Very High	Extreme
29+	High	Very High	Very High	Extreme	Extreme

No Army employee was able to describe either the method by which the category cutoffs were determined or how the IC or BI were calculated from the limited weather data available from the Bradshaw Weather Station. There was no significant correlation between fire danger rating and the size of fires, however, only 46 (6.5%) of the 709 total records that we procured included both a fire danger and a size for the fire.

Figure 9 and Table 6 illustrate the fact that areas receiving the highest use suffer the most frequent fires. Ranges 1, 8, 10, 11, and 12 are the most heavily utilized training locations at PTA. These areas are also at the top of the list of fire frequency locations. This is not surprising because areas receiving the highest use will also have the highest number of ignition sources.

Ranges 1 and 10 are both assault courses designed for squad and platoon size units respectively. There are several possible reasons why these two ranges are the most common

Figure 9
Percent of All Fires by Location at PTA
1987-1999*



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*Areas with fewer than 10 recorded fires are included in the "other" category.

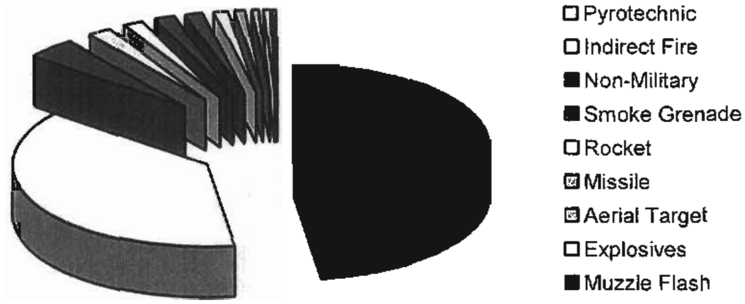
locations for fires. First, these are two of the most frequently used areas at PTA. Second it is common for a large number of rounds from a wide variety of weapons systems to be expended within the course of an exercise. These weapons systems may include anything from explosives to tracers. Finally, weapons are fired at a wide variety of elevation angles and in many directions, though always within the range fan. This, in combination with the necessity of making the exercises as realistic as possible, makes control of ignition sources difficult. Vegetation at ranges 1 and 10 is not significantly different than at other ranges and, therefore, was ruled out as a reason for the higher frequency observed.

Table 6: Number of recorded ignitions per location at PTA from 1987 to 1990.

Location	*Frequency*	*Location*	*Frequency*	*Location*	*Frequency*	*Location*	*Frequency*
Range 10	134	Twin Pu'us	12	Area 4	4	BAAF	2
Range 1	122	Range 9	11	Area 8	4	MPRC	2
Range 12	113	Area 16	9	K. Kalawamauna	4	Area 10	1
Range 8	70	Range 20	9	Range 3	4	Area 17	1
Range 11	44	Area 1	8	Area 15	3	Area 21	1
Range 4	24	Range 13	8	Area 5	3	Area 3	1
Impact Area	16	Area 7	7	Area 9	3	New FAARP	1
Pu'u Ahi	14	Off Post	6	Range 5	3	POL	1
Old FAARP	13	Range 2	5	Range 10	3	Range 16	1
Redleg Trail	12	Area 18	4	Area 12	2	Range 7	1
Saddle Road	12	Area 22	4	Area 13	2		

Ranges 8 and 12 are utilized for machine gun and sniper qualification and instruction. It is likely that the large number of tracer rounds expended on these ranges is responsible for the high fire frequency here.

Figure 10
Percent of All Fires by Ignition Source at PTA
1994-1999



The remaining locations identified in Figure 9 all have one of two factors in common: either a low volume of ammunition used or weapons systems with low ignition probabilities. While some of the weapons systems fired may pose a high danger of fire (see Table 7), they are generally heavy weapons that are fired infrequently such as missiles, rockets, and demolition explosives. Some areas are restricted to low ignition probability weapons such as ball ammunition and hand grenades, or are areas in which no ammunition is fired at all, Saddle Road for example.

Of all of the fires started on or burning onto PTA, by far the most common cause is tracer ammunition (Figure 10). Tracers easily start fires and are one of the most commonly used ammunitions. The Unknown category probably includes a large number of tracer caused fires as well, if we can assume that unknown ignition sources follow the same patterns as those that are known.

It is important to note that the overwhelming majority of the acres burned at PTA have been caused by fires originating from non-military sources. Since July 1990, 8,424 acres have been recorded as burned. Of these, over 7,700 acres, or 91%, of all acres burned were by fires caused by lightning, arson, or carelessly discarded cigarettes, and the largest of these started off Army lands and later burned onto PTA.

Map 2 shows the extent of a number of significant fires that have burned in Pu'u Anahulu and map 3 shows the location and frequency of ignitions in and around PTA. These maps suggest that fires that are ignited on Army lands tend to be located in areas that have a much lower concentration of T&E species, while fires that start off Army lands and burn onto them

Table 7: Fire ignition potential of weapons/ammunition cleared for use at PTA

Weapon	*Ammunition*	*Fire Potential*
Rifle Pistol Machine Gun Shot Gun	Ball .50 Caliber 5.56 mm, 7.62 mm, 9 mm Buckshot	Low
	Tracer 5.56 mm, 7.62 mm, 9 mm 40 mm Target Practice Training (TPT), Illumination (ILLM), High Explosive (HE), High Explosive Dual Purpose (HEDP)	High
Helicopter Guns	20 mm ball	High
Mortar and Artillery	60 mm HE	Low
	60 mm ILL	High
	81 mm HE, TP	Low
	81 mm ILLM, Smoke (SMK), Red Phosphorous (RP), White Phosphorous (WP)	High
	105 mm HE	Low
	105 mm WP, HC, Smoke	High
	155 mm HE, Laser Guided (Copperhead)	Low
	155 mm WP, Smoke, ILLM	High
AT-4 Anti-Tank Weapon	84 mm HE Anti-Tank Rocket	Low
Light Anti-Tank Weapon (LAW)	66 mm HE Anti-Tank Rocket	Low
	35 mm Subcaliber Practice Rocket	High
Folding Fin Rocket	2.75 in WP, ILLM	Low
Medium Anti-Tank Weapon	Tactical Missile	High
M47 (Dragon Missile)	Inert Missile	Low
Shoulder-Launched Multipurpose Assault Weapon (SMAW)-Marines	SMAW Practice, SMAW Common Practice	Low
Tube Launched, Optically Tracked, Wire Command Link (TOW)	Inert	Low
	HE	High
Stinger	Shoulder-Fired Heat Seeking Surface-to-Air Missile	Low
Ballistic Aerial Target System (BATS)		Low
Bombs	MK-10, MK-76 (25 lbs. Practice) MK-82 (500 lbs.), MK-83 (1000 lbs.), MK-84 (2000 lbs.)	High
Grenades (Hand and Rocket Propelled)	M67 Fragmentation, Practice	Low
	WP, Smoke	High
Mines	Claymore Antipersonnel, Land Mines (Anti-Tank Mines)	Low
Demolition	TNT, C-4 Block, Detonation Cords, Bangalore Torpedo	Low
Flare	White Parachute	High

From Preliminary Draft Biological Assessment for PTA 1999

tend to occur in areas of high T&E species concentration. Two major fires have burned through Kipuka Kalawamauna in the past six years. These two fires account for 91% of all recorded acres burned within PTA in the past decade. These figures clearly indicate that the priority for fire management must focus on protecting Kipukas Kalawamauna and Alala from civilian ignited fires moving up from Mamalahoa Highway and Pu'u Anahulu.

The one exception to this generality is the Twin Pu'us area. This area has the potential for a major fire because of the high density of *Pennisetum setaceum* that provides a fire corridor to the top of Kipuka Kalawamauna and the high ignition probability weapons that are fired at the Twin Pu'us.

1.4 Conclusions and Recommendations

Fire frequency and size at PTA follow the same patterns expected of fires throughout the U.S. The highest fire frequency occurs during the hottest, driest part of the day and year. The frequency and types of training appear to have an effect on fire frequency. Areas that are heavily utilized and that are designated for high ignition probability weapons systems such as tracer ammunitions have the highest fire frequency, while areas designated for low ignition probability weapons or areas that are infrequently used have the lowest fire frequency.

In general, the fire history for PTA clearly demonstrates that civilian ignitions pose a major threat to T&E species within the military boundary. In comparison, military ignitions, while far more frequent, tend to occur in areas that are of lower protection priority and burn fewer acres. These two facts indicate that fire protection priorities need to be placed along the western PTA boundary to create a network of firebreaks and fuel management areas that will impede or stop fires approaching from Pu'u Anahulu.

The recommendations for PTA follow closely those made for Makua Military Reservation. First, fire records should be kept for every fire, regardless of extent or severity. These records should include:

- Date of ignition*
- Time of ignition*
- Ignition source*
- Date declared out
- Time declared out